

Climate Change: Observed & Projected Impacts

**Presentation to the National Association of Insurance Commissioners
(NAIC) 2005 Spring National Meeting
Consumer Liaison Committee**



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Intergovernmental Panel on Climate Change - WGII Plenary/Geneva

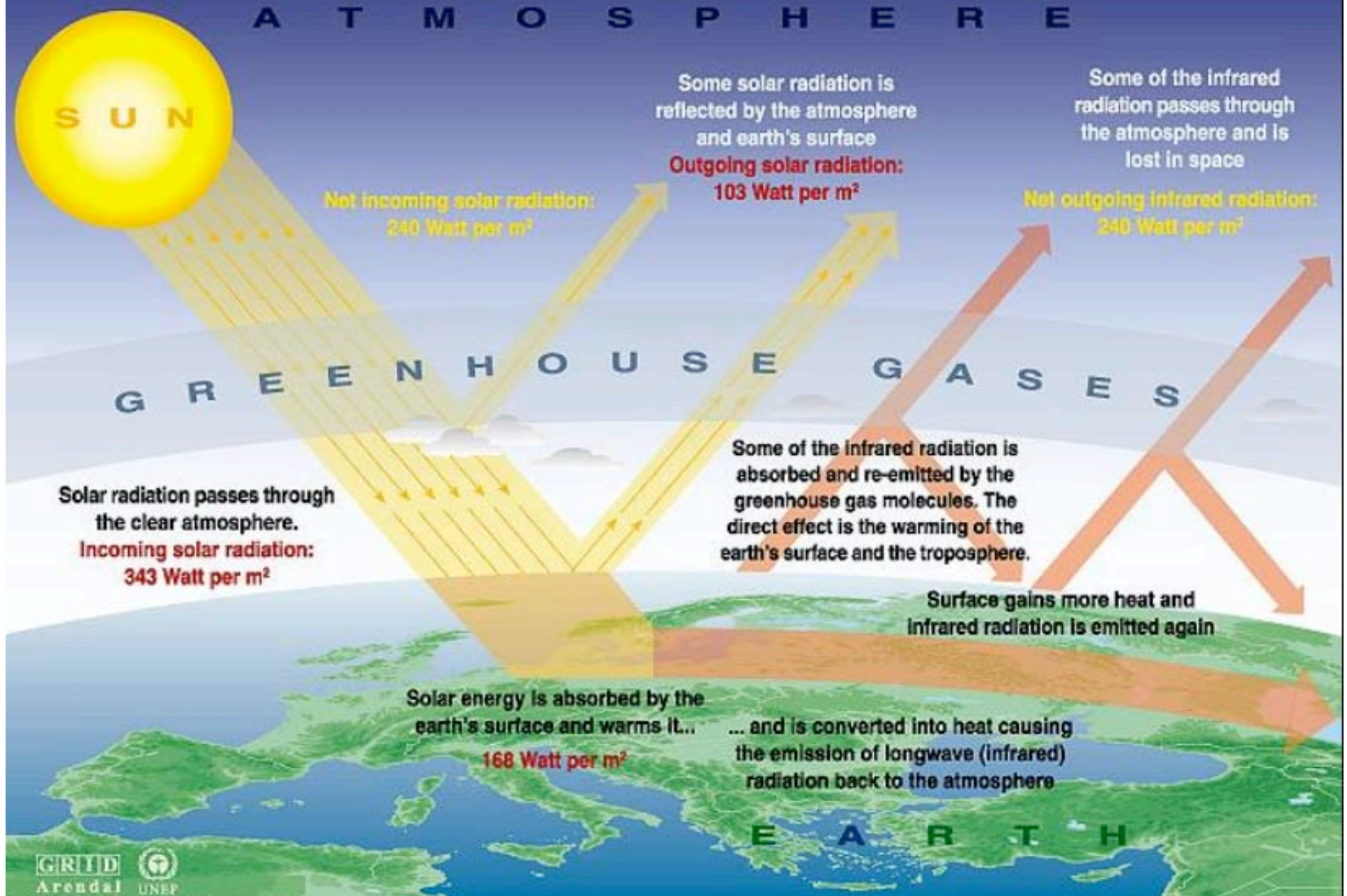
A high-angle photograph of a large, semi-circular conference hall. Delegates are seated at long, curved desks arranged in a semi-circle, facing a stage. On the stage, there is a large projection screen displaying text, and a large United Nations emblem is mounted on the wall to the right. The room is dimly lit, with the primary light source being the screen and some stage lighting.

Operated by the UN: WMO and UNEP

Entering our 4th 5-year cycle of review
and synthesis of scientific literature

- 1300 Authors; 1100 Expert Reviewers
- Policy relevant (not policy prescriptive)

The Greenhouse effect



CO₂ Creates a Heat-Trapping Blanket

A Tale of Three Planets

Mars

Thin atmosphere

(Almost all CO₂ in ground)

Average temperature : - 50°C



Earth

0.03% of CO₂ in the atmosphere

Average temperature : + 15°C

[minus 15°C (or 5°F) without CO₂]



Venus

Thick atmosphere

containing 96% of CO₂

Average temperature : + 420°C

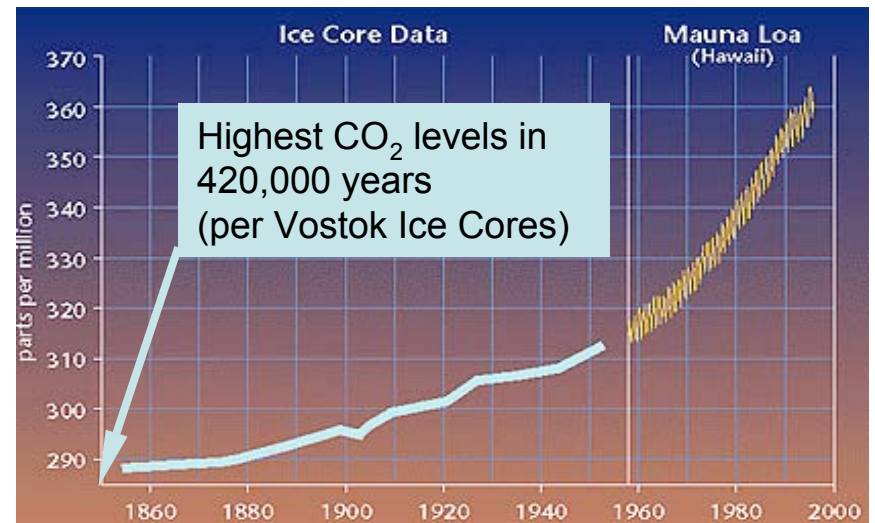
[only 50°C without CO₂]



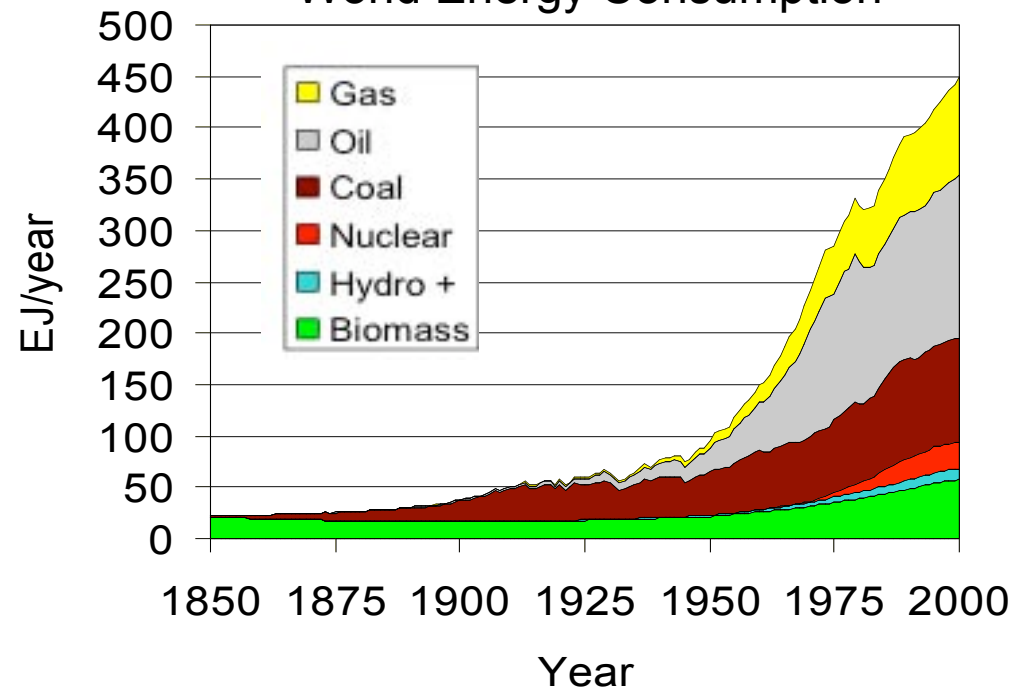
Greenhouse Gases

- Observed climate-change phenomena are consistent with the predictions of climate science for human-caused GHG-induced warming
- No alternative “culprit” identified so far – no potential cause of climate change other than greenhouse gases – yields this “fingerprint” match
- A credible alternate theory would need to explain both what the alternative cause of the observed changes is and how it could be that GHGs are NOT having the effects that all current scientific understanding says they should have

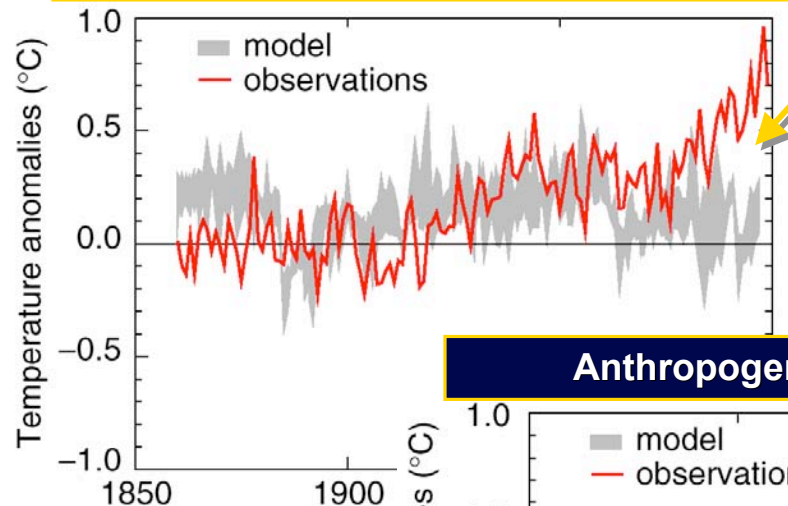
World Carbon Dioxide Concentrations



World Energy Consumption



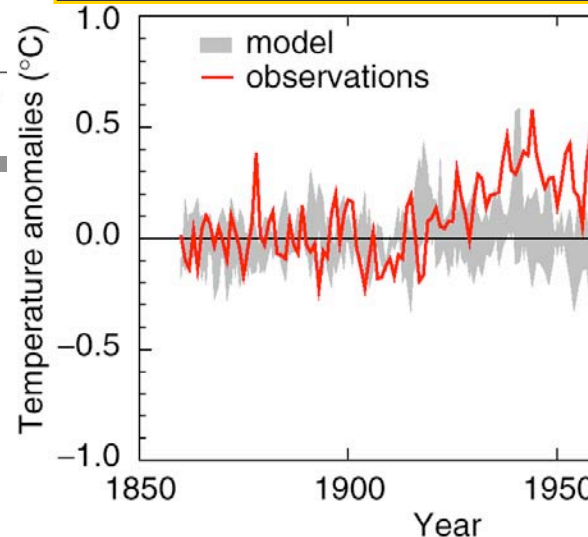
Natural Forcing



- Natural (solar + volcanic) forcing alone does not account for warming in the past 50 years.

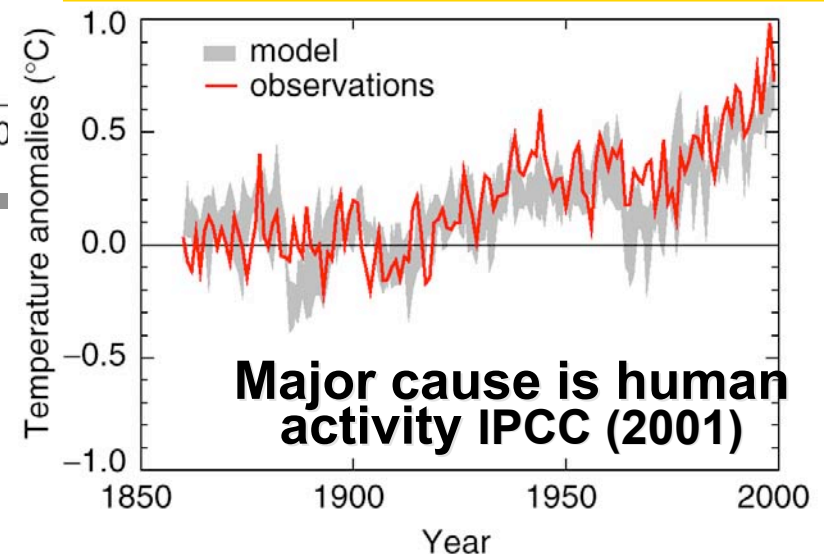
1°F *average* warming thus far

Anthropogenic Forcing Only



- human influences alone (greenhouse gases and sulfate aerosols) brings the models and observations into pretty good agreement.

Natural and Anthropogenic Forcing

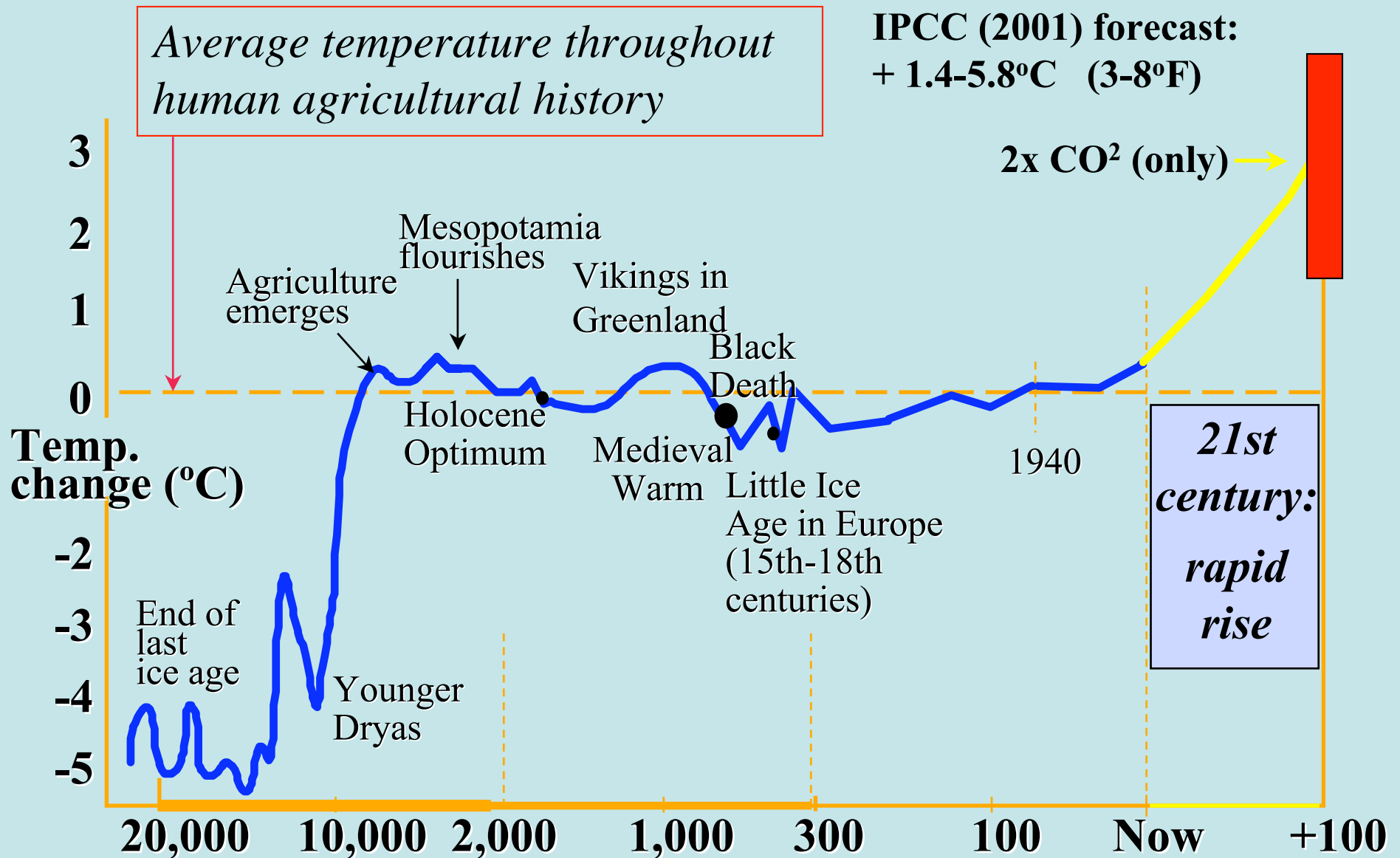


Major cause is human activity IPCC (2001)

Fingerprint:
Temperatures
higher than in past
1000 years, and
increasing at
fastest rate over
this period

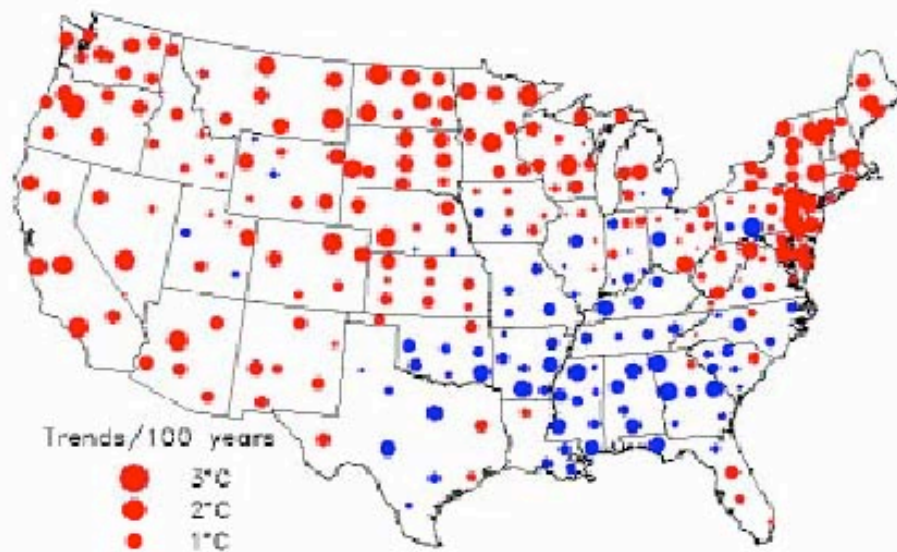
>> *“Warming Commitment” is greater:
Most of warming still locked in the oceans*

Temperatures: Past and Future



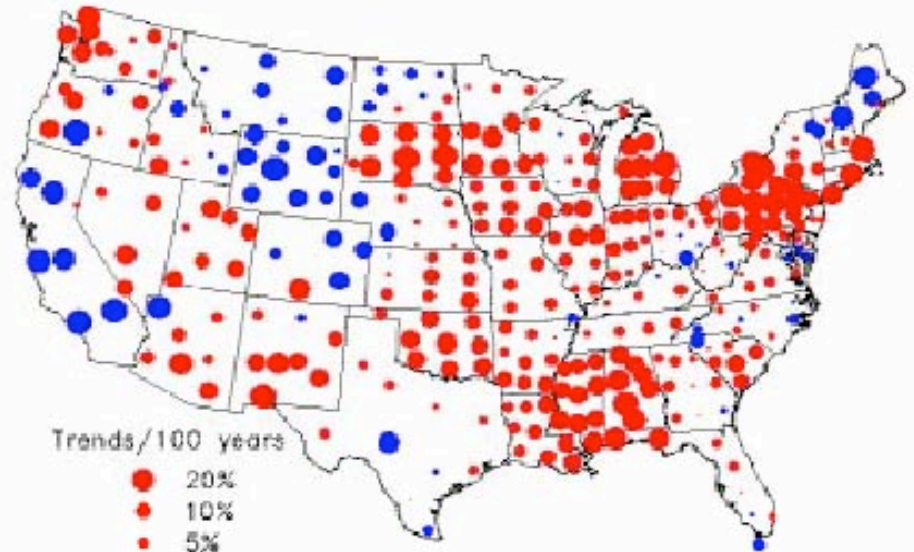
Fingerprints: Temperature and Precipitation Departures from Normal

Temperature



Red circles reflect warming;
Blue circles reflect cooling

Precipitation

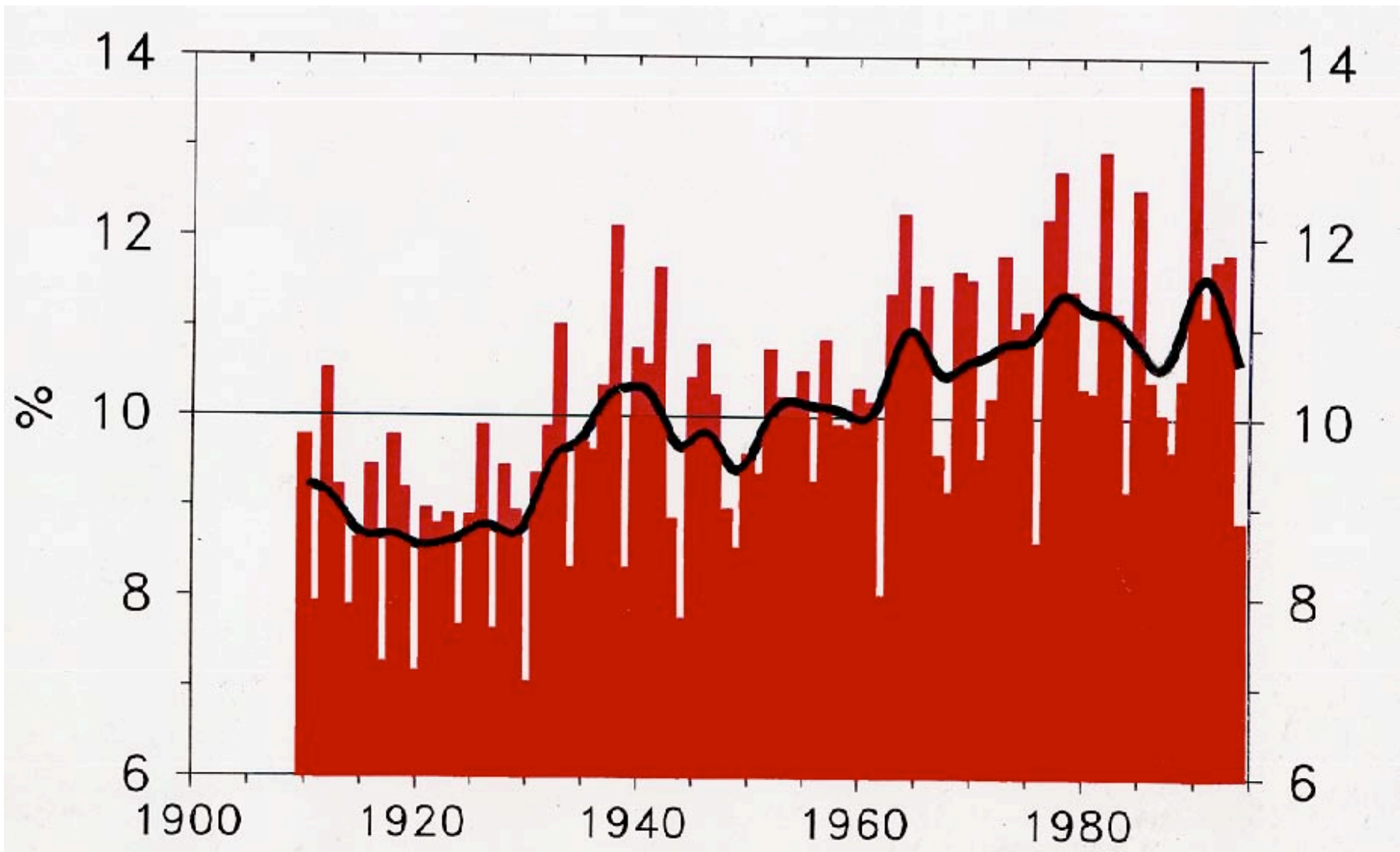


Red circles reflect increasing precipitation;
Blue circles reflect decreasing precipitation

Note: Cooling in southeast U.S. may be due to sulfate aerosol influence

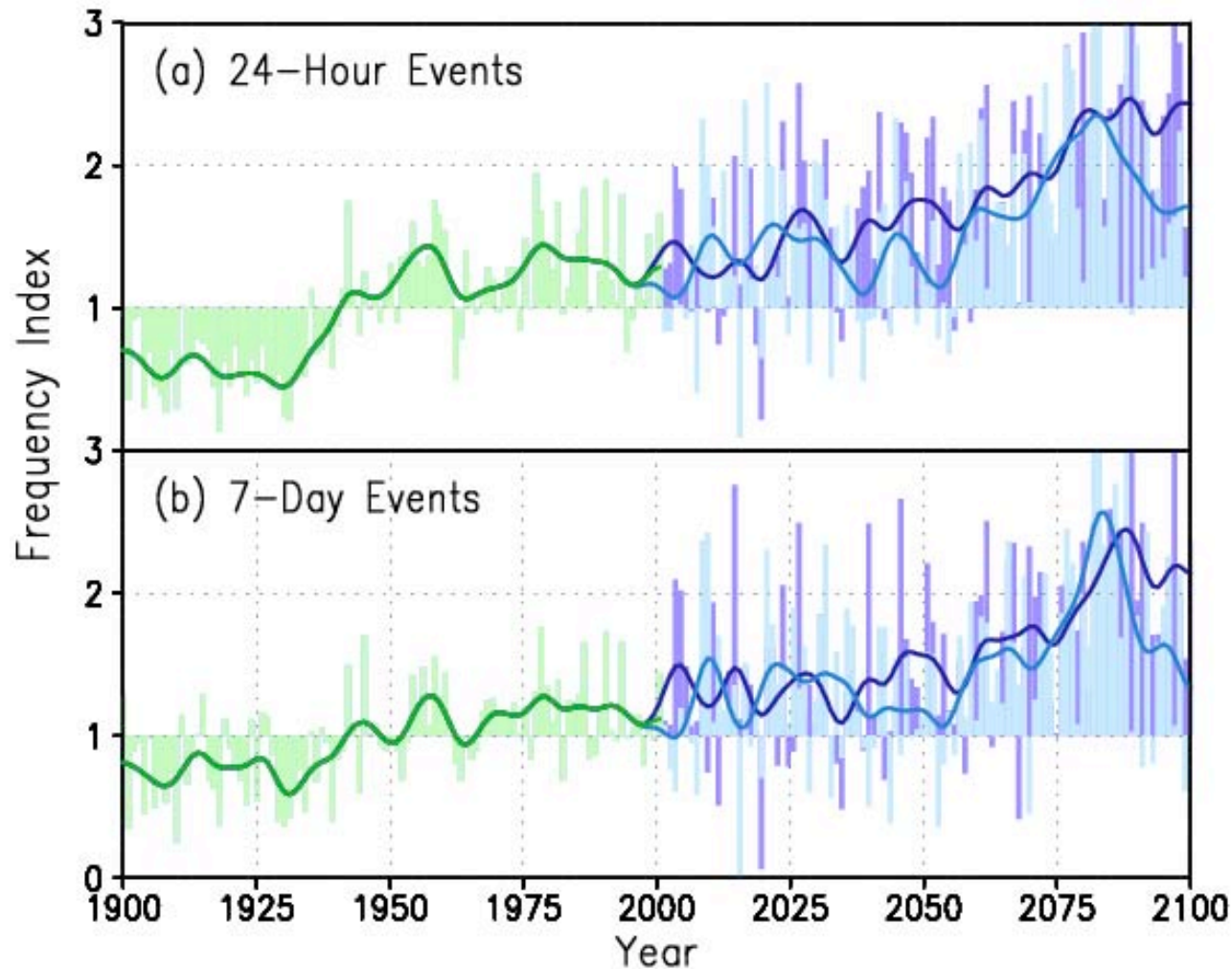
Source: Karl et al. (1996)

Fingerprint: Percent of the Continental U.S. with Above-normal Proportion of Torrential Rainfall



Fingerprint: Torrential Rain

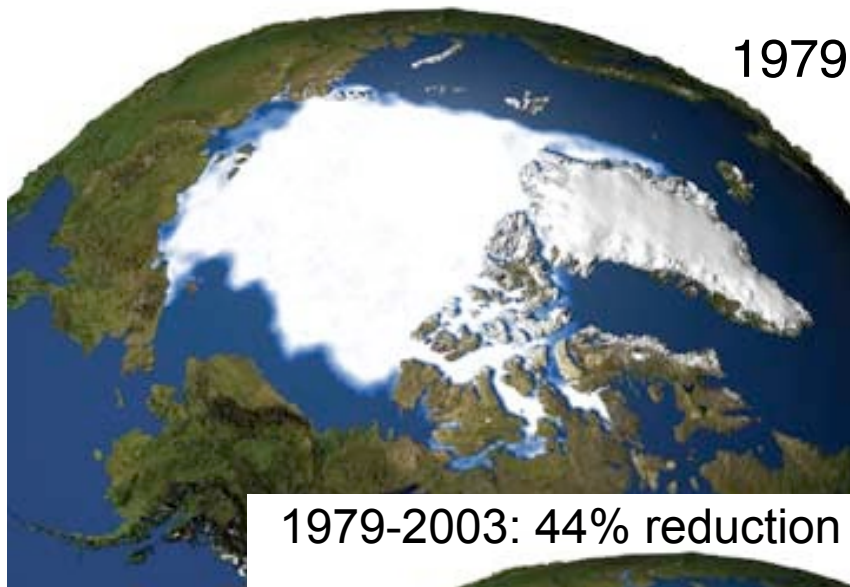
Great Lakes Region



Projections:

- Doubling of heavy precipitation events
- Seasonal shifts in precipitation –
 - * More rain in winter and spring (planting season)
 - * Less rain during the summer and fall growing seasons

Fingerprint: Loss of Ice & Snow Cover



1979

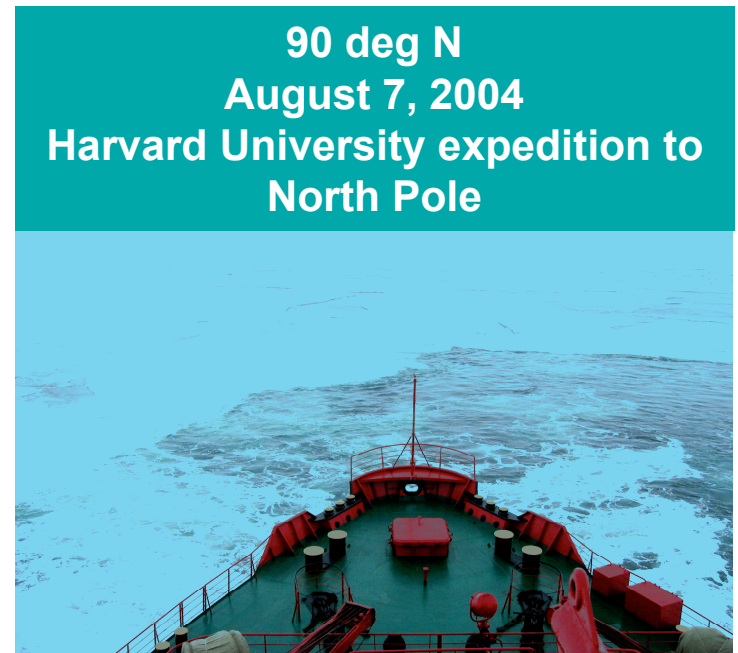
1979-2003: 44% reduction in thickness



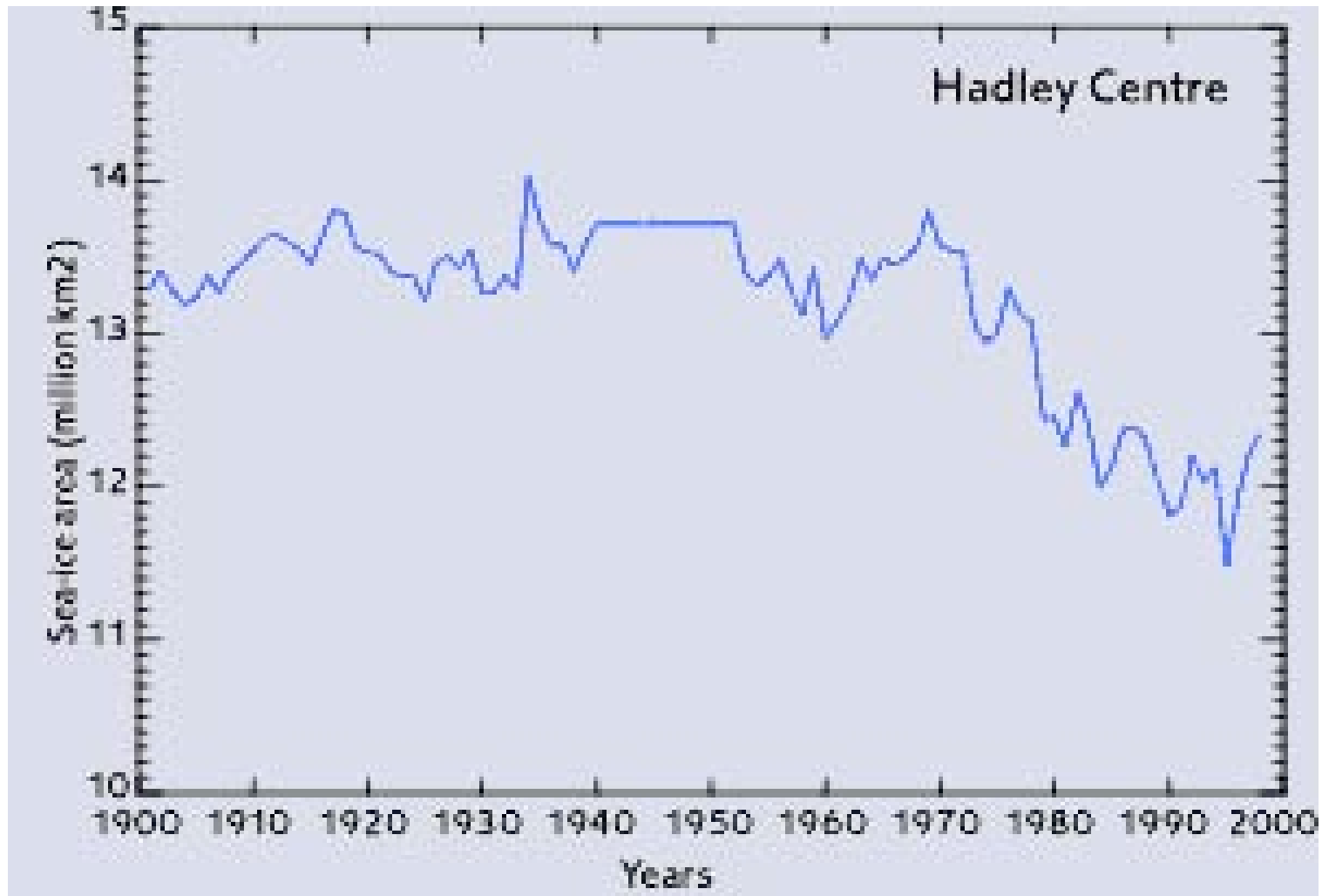
2003

Implications:

- Loss of land ice contributes to sea-level rise
- “Darkens” Earth’s surface
- “Sweetens” northern oceans



Fingerprint: Sea-Ice Extent Has Dropped by 1 M miles² Since 1970



Fingerprint: Worldwide Glacier Retreat

Americas

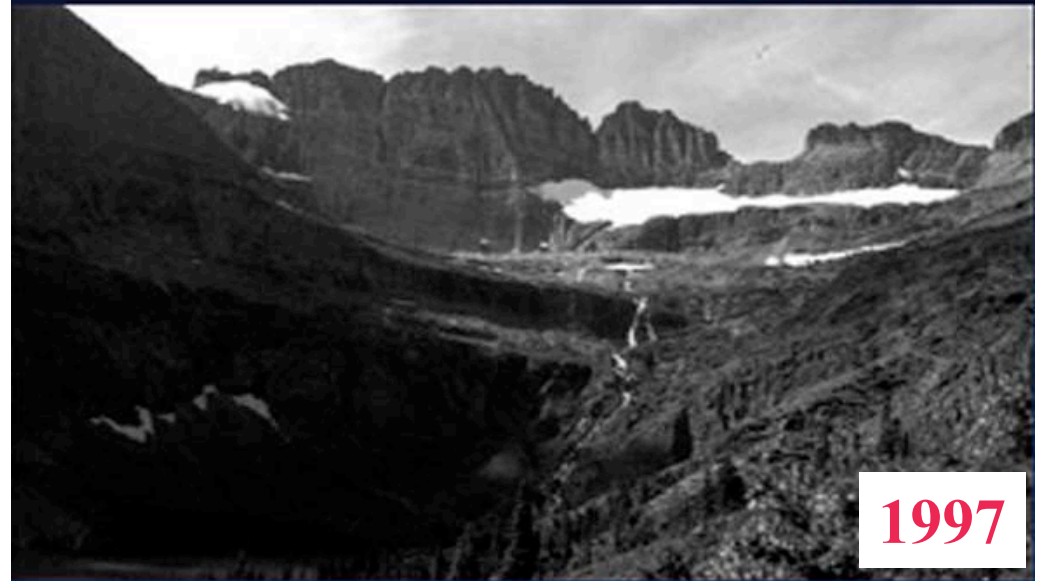
Europe

Asia

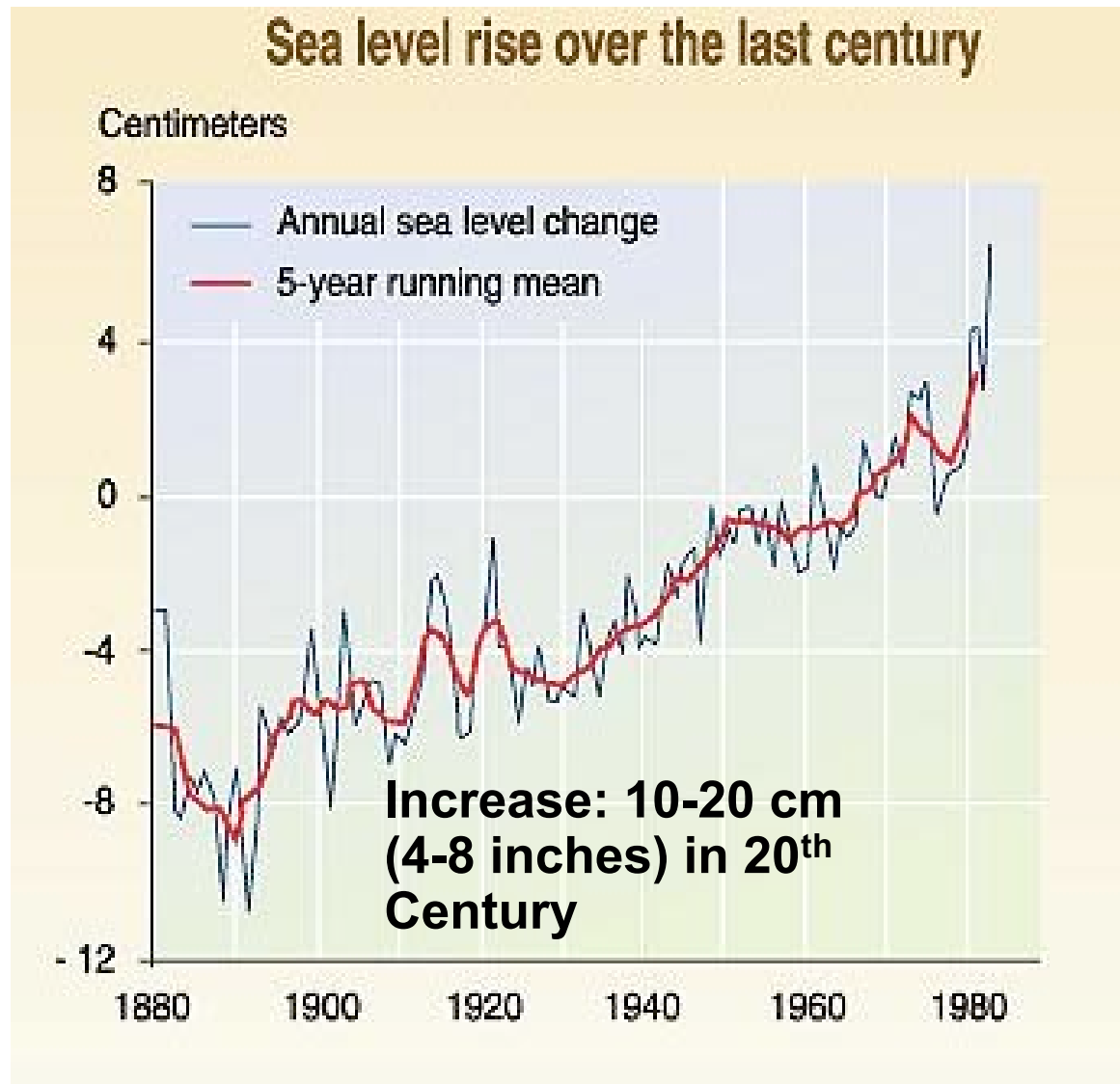
Africa

Australasia

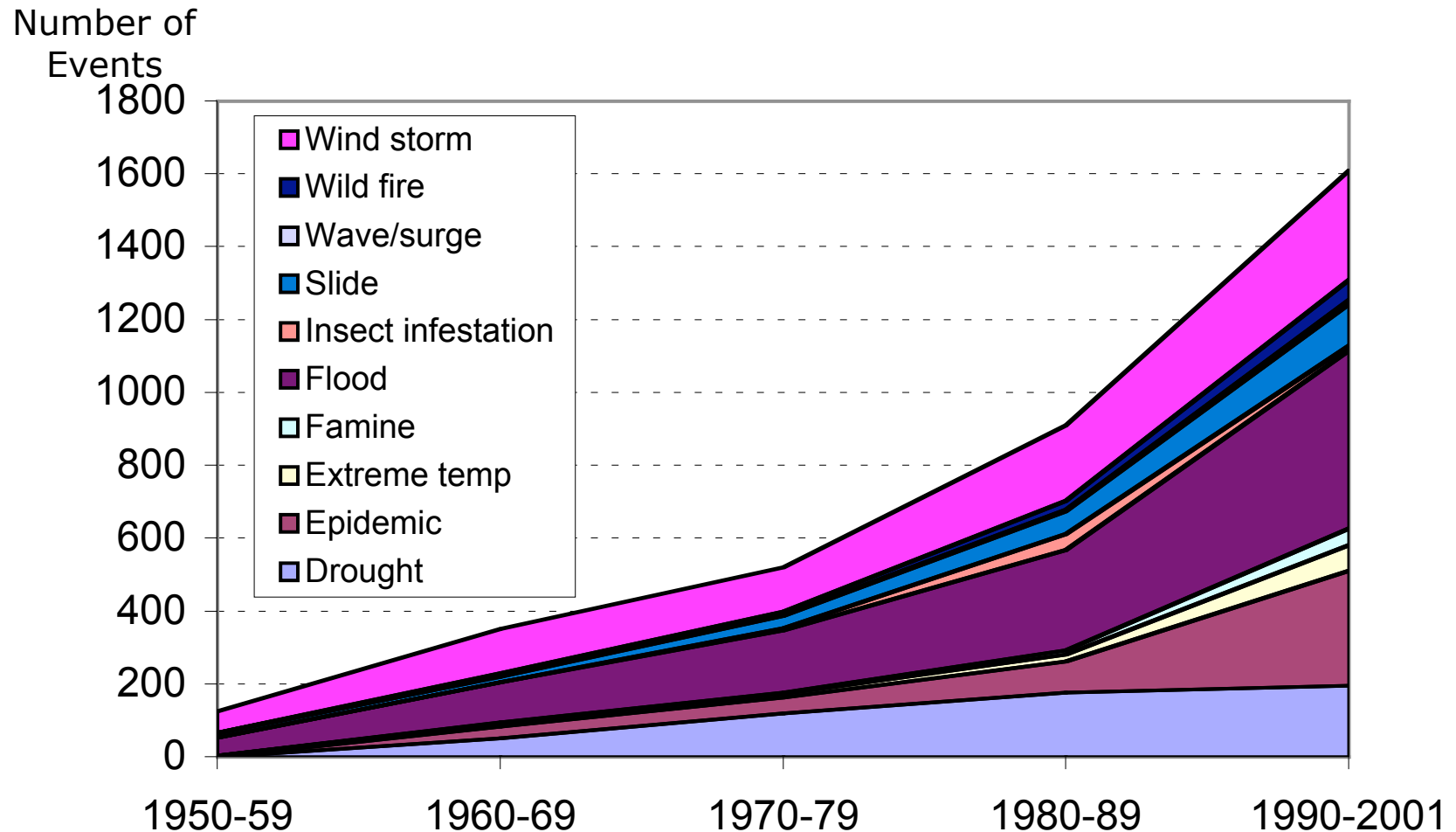
Grinnell Glacier,
“Glacier” National
Park, USA



Fingerprint: Sea Level Rise

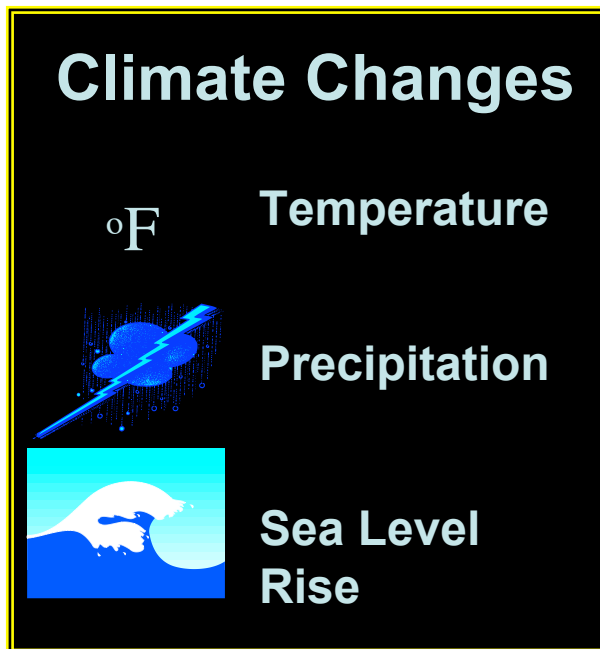


Fingerprint: Rise in Number and Change in Mix of Natural Disasters



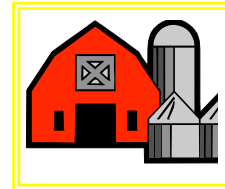
Source: Center for Research in the Epidemiology of Disasters (CRED)

Climate change leads to a range of important impacts



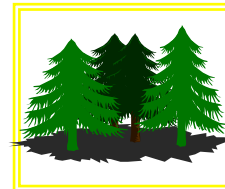
Health Impacts

Weather-related mortality/heat stress
Infectious diseases
Air quality-induced respiratory effects



Agriculture Impacts

Crop yields and commodity prices
Irrigation demands
Pests and weed



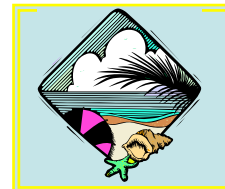
Forest Impacts

Change in forest composition
Shift geographic range of forests
Forest health and productivity



Water Resource Impacts

Changes in water supply and timing
Water quality
Increased competition for water



Coastal Area Impacts

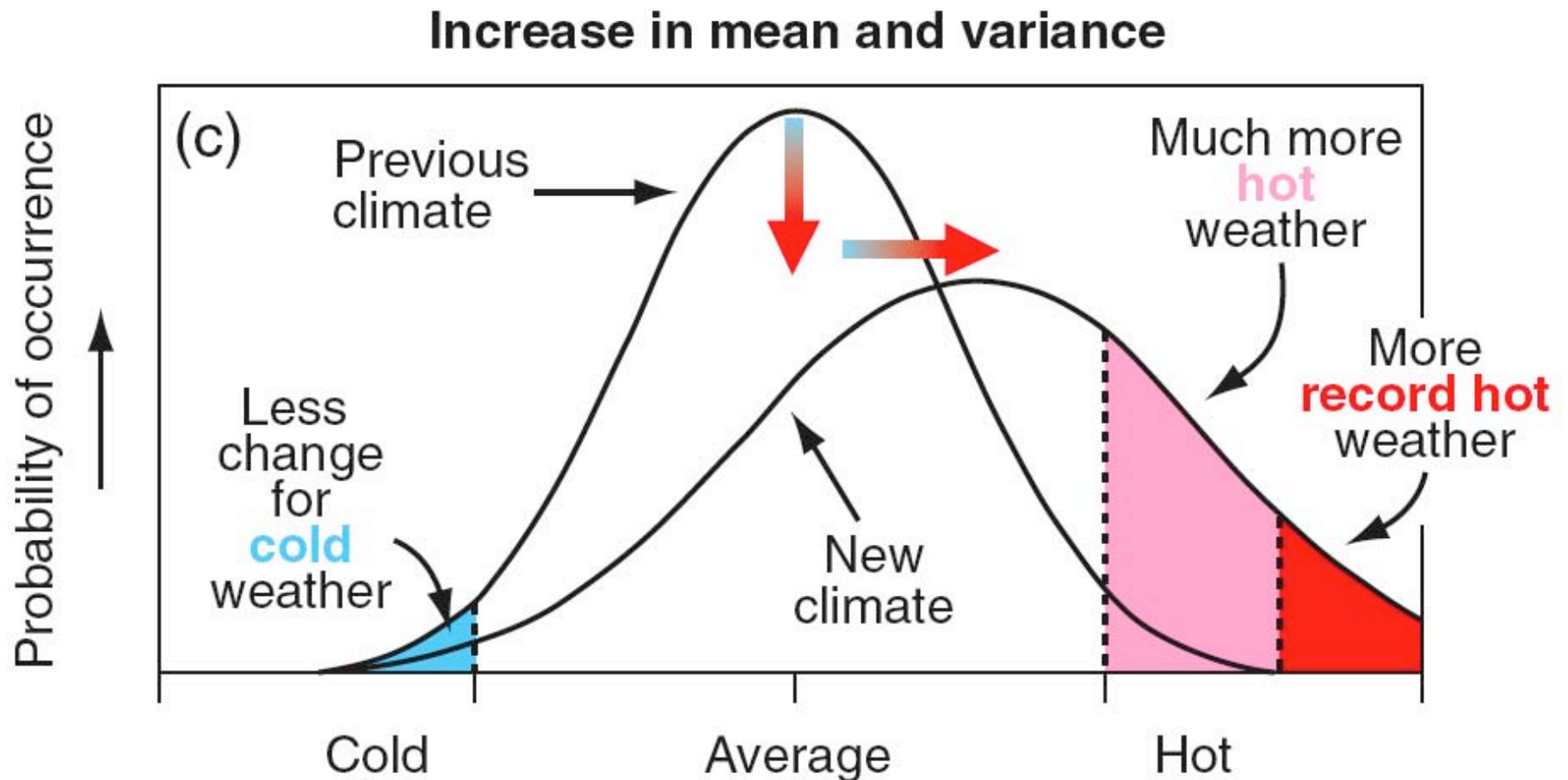
Erosion of beaches
Inundation of coastal wetlands
Costs to defend coastal communities



Ecosystem Impacts

Shifts in ecological zones
Loss of habitat and species
Coral reefs threatened

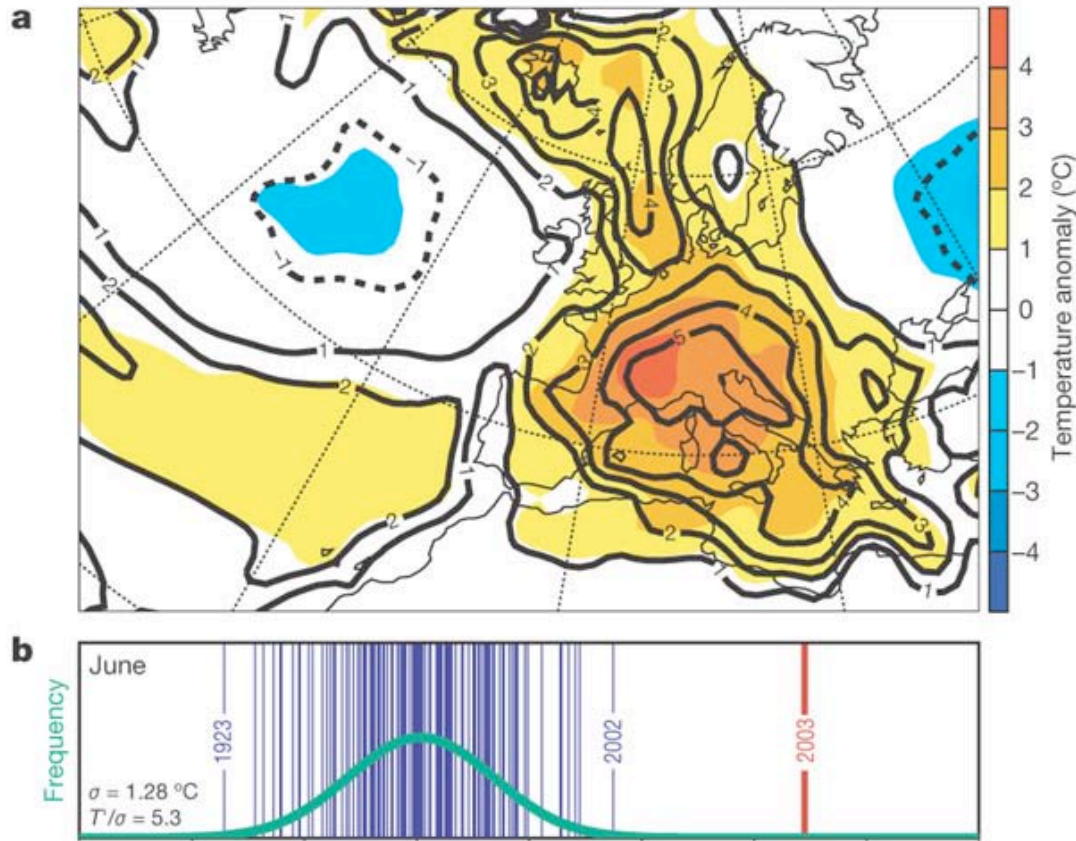
Changes in Averages Create Even Greater Changes in Extremes



Source: IPCC, Third Assessment Report

Example: the 2003 European Heat Wave

(hottest summer since 1500 AD)



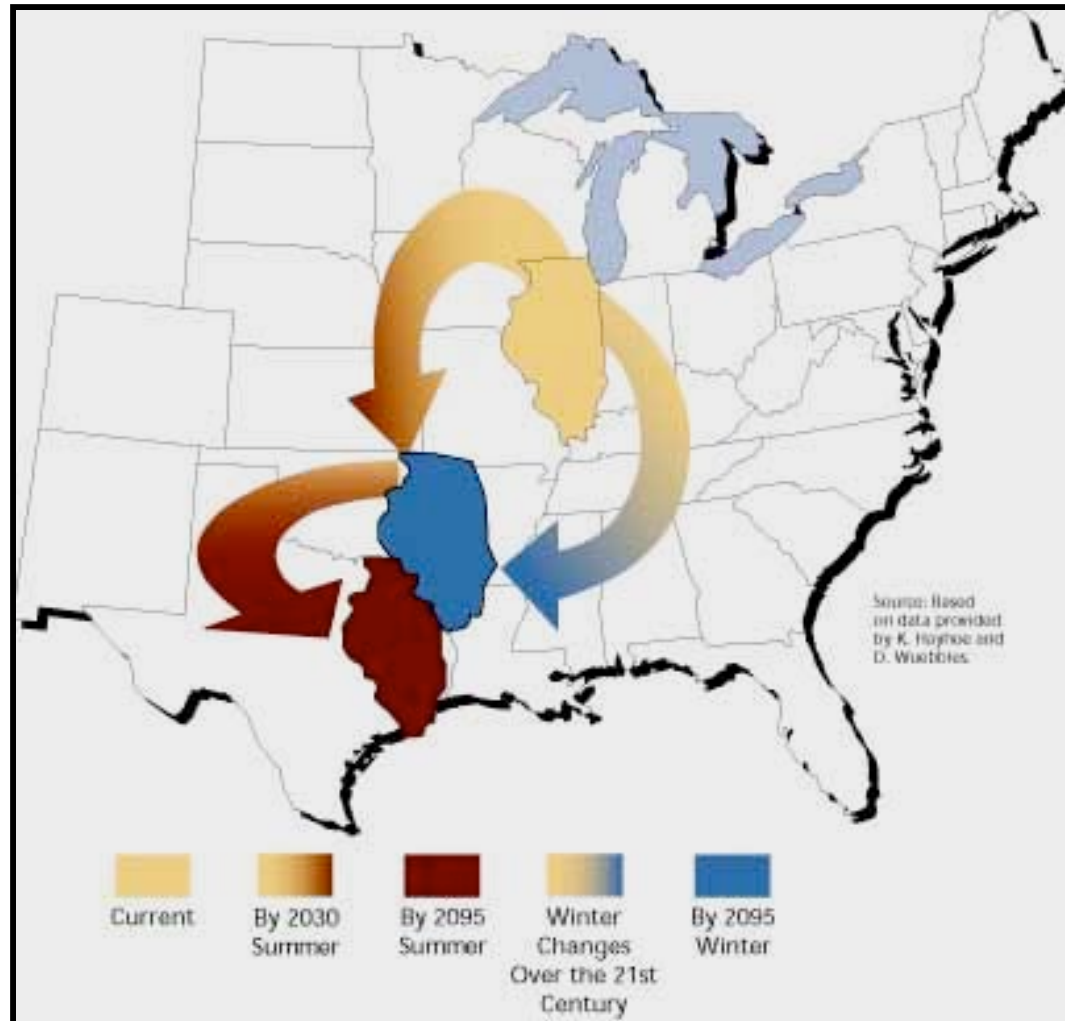
Green: Fitted Gaussian distribution; **Red:** 2003

Source: Schar 2004 (*Nature*)

- Multiple correlated, impacts:
 - 22,000-35,000 human fatalities
 - \$13.6B in crop losses
 - \$1.7B in wildfires in Portugal alone + respiratory illness
 - Nuclear power plant curtailment (insufficient cooling water)
 - Unhealthy air masses (smog, particulate)

Shifting *Location* of Extremes

Projected Climate - Illinois



- By the end of this century, temperatures expected to rise 9-18 degrees F in summer; 7-13 degrees F in winter
- More precipitation in winter and spring
- Less precipitation in summer and fall
- More precipitation falling in extreme events (50-150% higher than today)

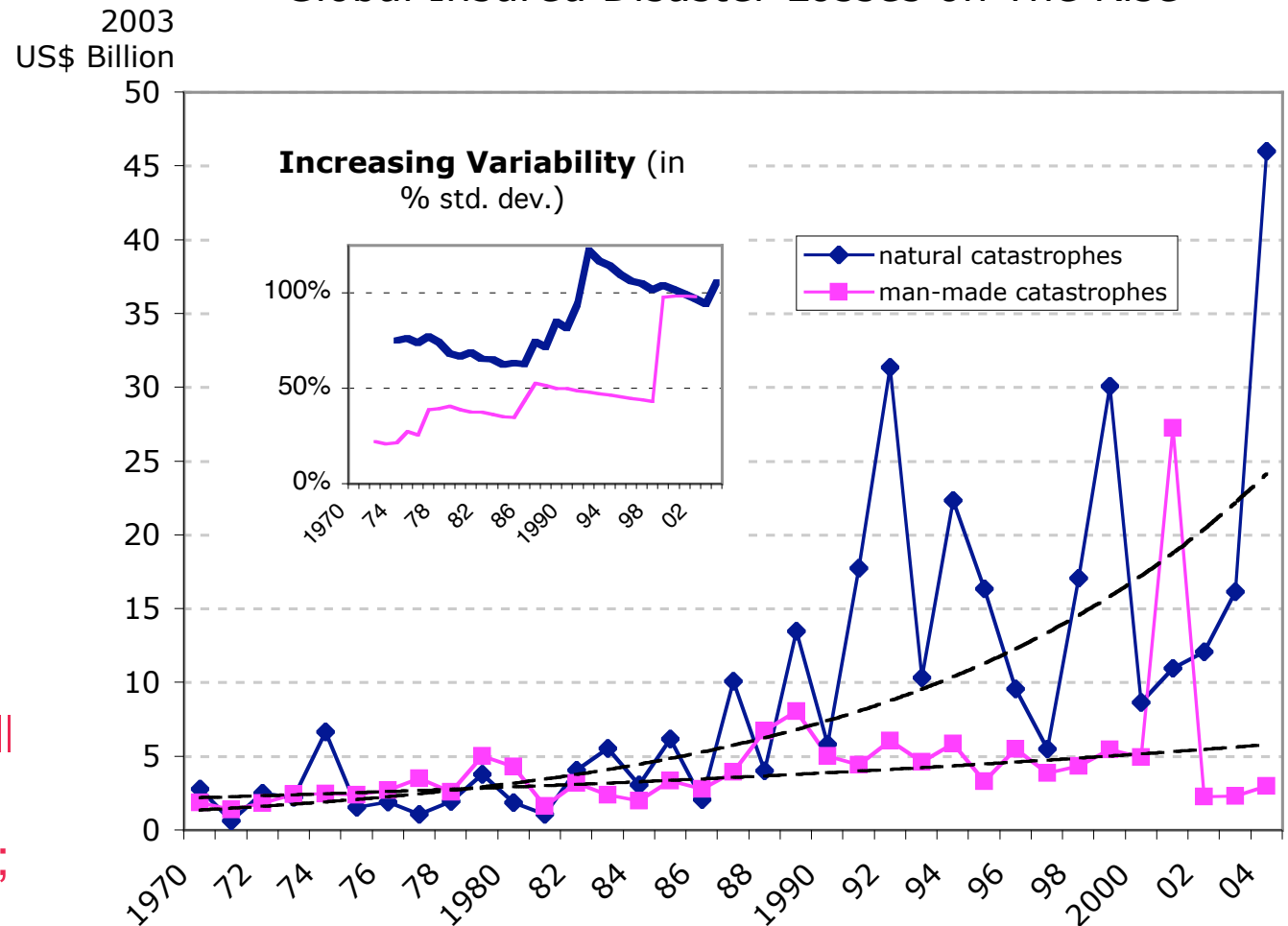
Uncertainty: Physical ➡ Financial

“Catastrophe insurers can't simply extrapolate past experience.”

- *Warren Buffett* (1992)

Note: diagram shows **only large events** (small events *double* these totals) and **excludes health/life losses**. Including small scale events would double these numbers; health-related losses unknown

Global Insured Disaster Losses on The Rise



Source: Swiss Re (*Sigma*)

Small-scale, Gradual, Diffuse, and Indirect Events Often Overlooked

- **Small-scale**

- Storms, Subsidence, Lightning, Hail, Ice Storms, Wildfire, Equipment Breakdown, Blackouts, Vehicle damages/injuries, Mudslides



- **Gradual/Diffuse**

- Sea-level rise, Drought, Infectious diseases



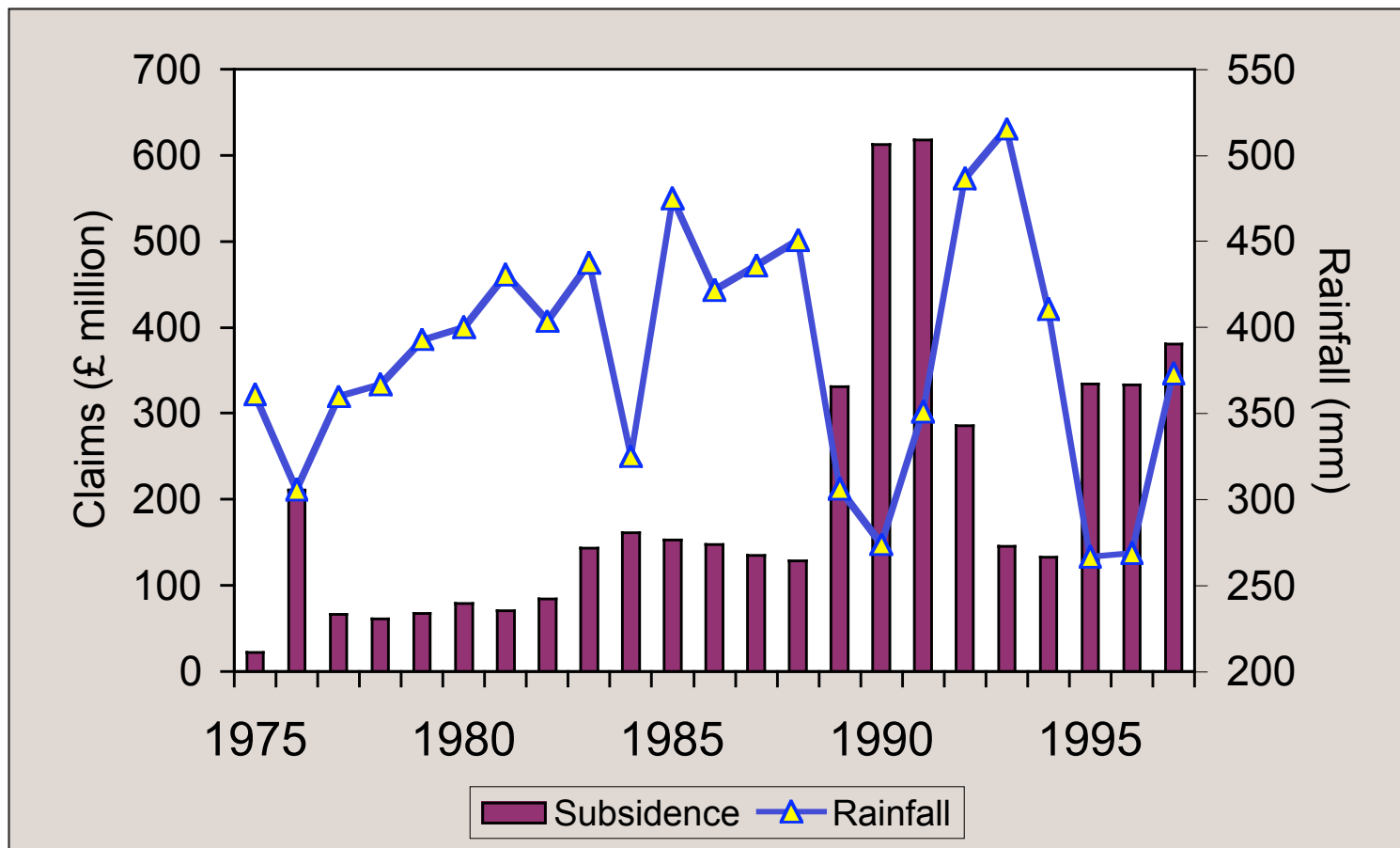
- **Indirect**

- Eroded water quality
- Eroded air quality
- Health (human, crops, etc.)
- Amplification of poverty (slows market growth; elevates political risk)



Temperature-Related Insurance Loss Experience

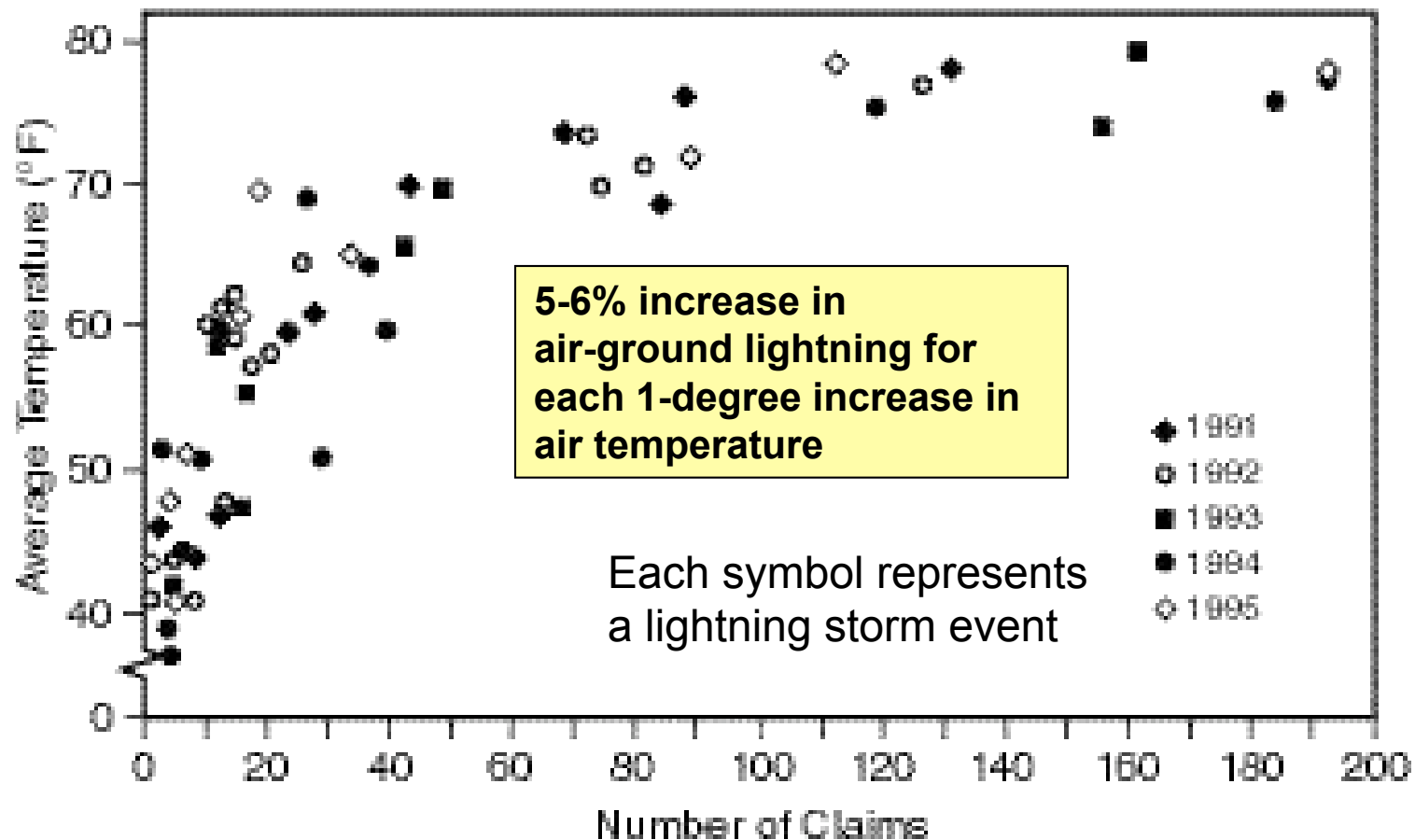
Subsidence claims increase with drought: UK 1975-1999



Source: Association of British Insurers

Temperature-Related Insurance Loss Experience

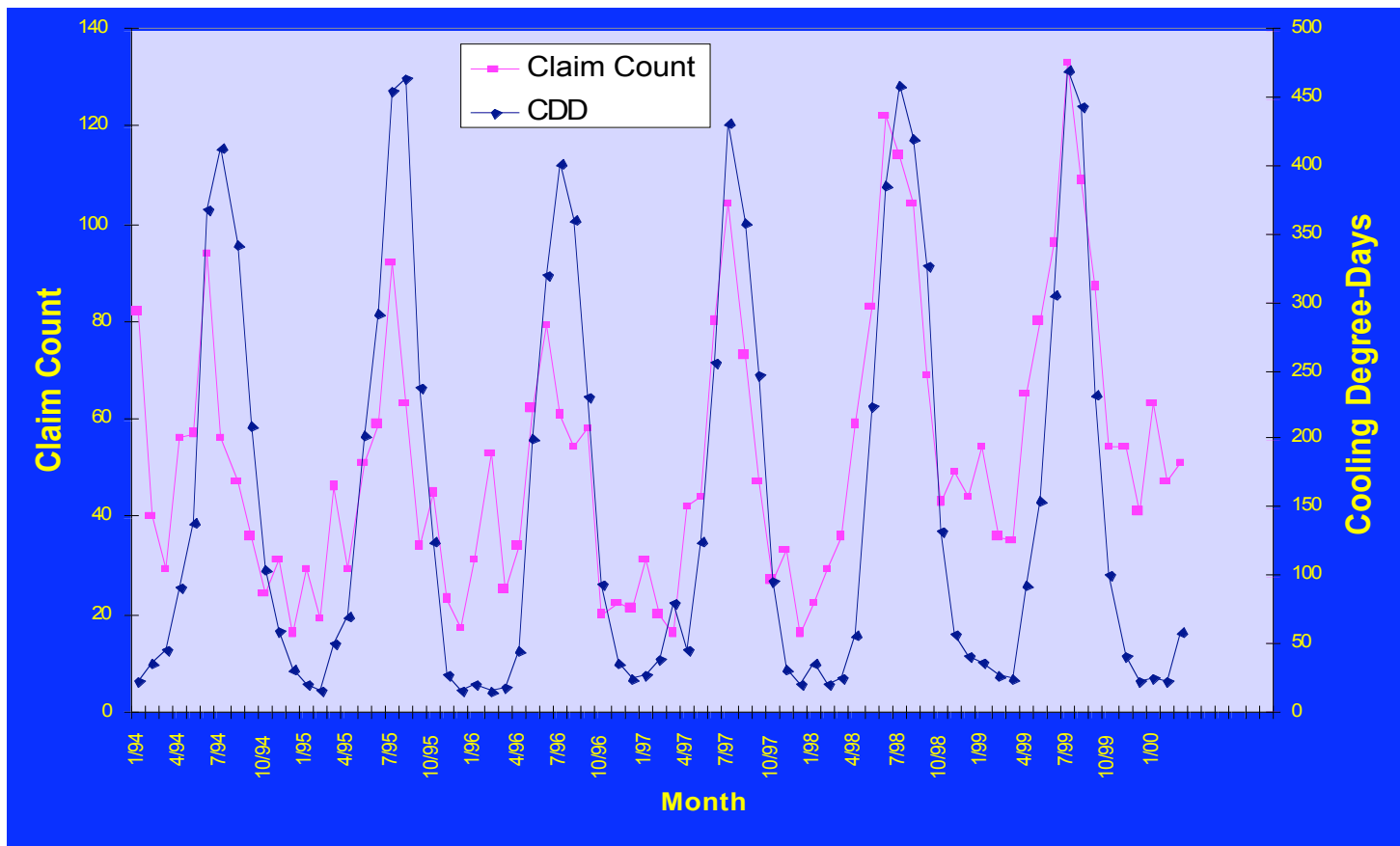
Lightning-related claims *accelerate* with temperature



Source: Hartford Steam Boiler Inspection and Insurance Co.

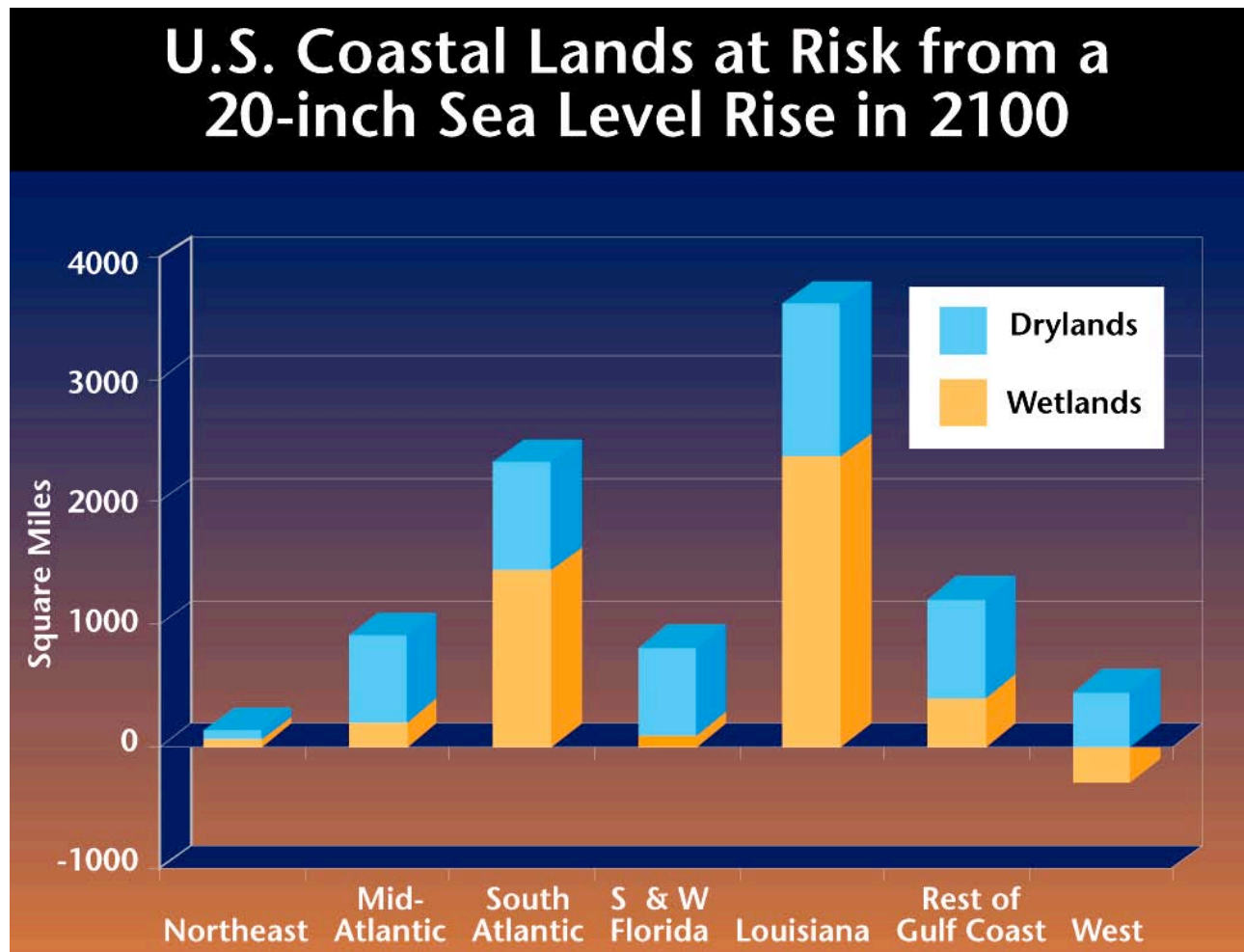
Temperature-Related Insurance Loss Experience

Air-conditioning breakdown claims increase
with cooling degree days: 1994-1999



Source: Hartford Steam Boiler Inspection and Insurance Co, 2001

Future Sea-level Rise



Nationally: 25% of homes within 150 yards of current high-tide mark at risk over next 60 years

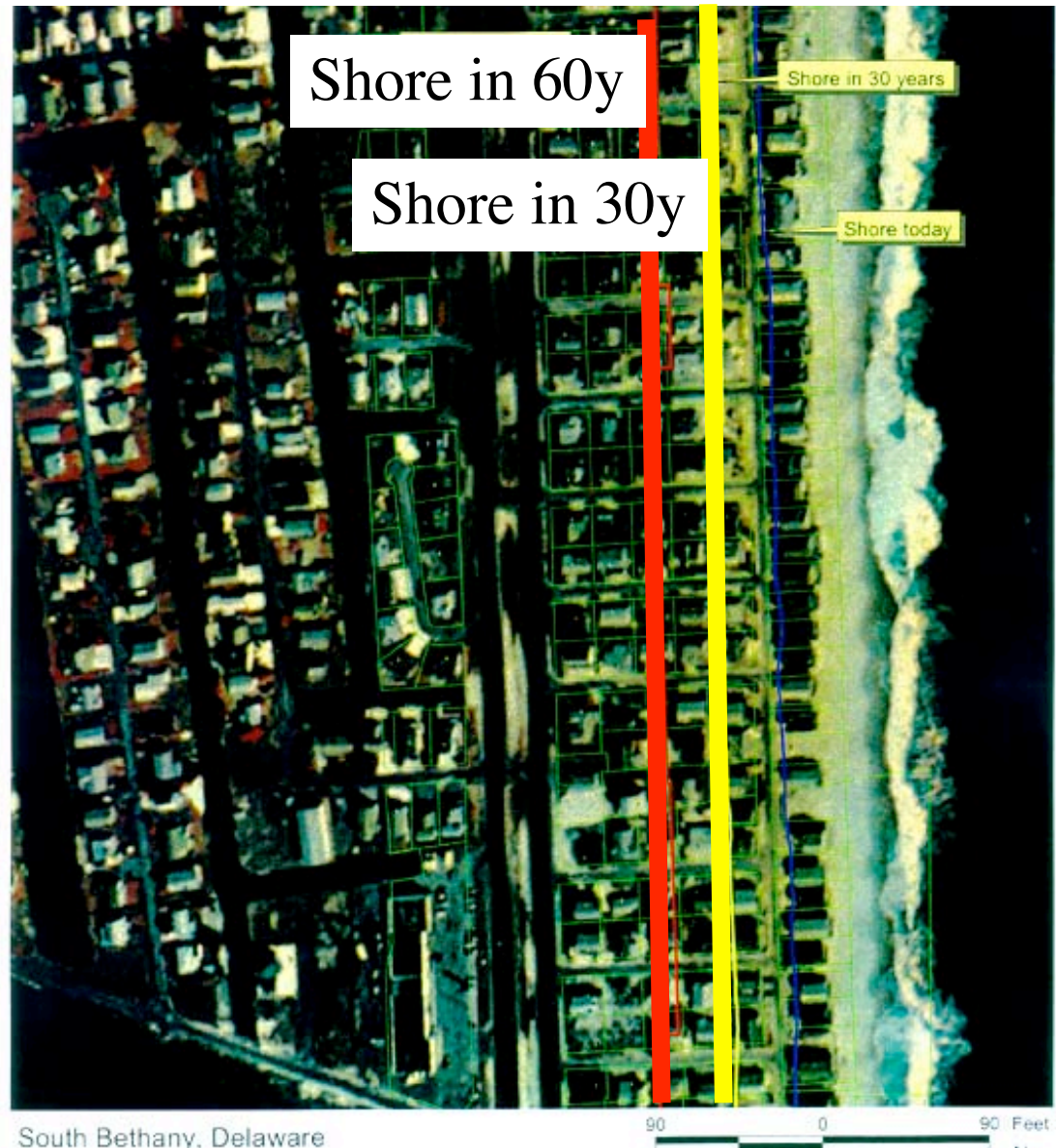
Source: Heinz Center (for FEMA)

Source: USEPA

Property Loss from Coastal Erosion

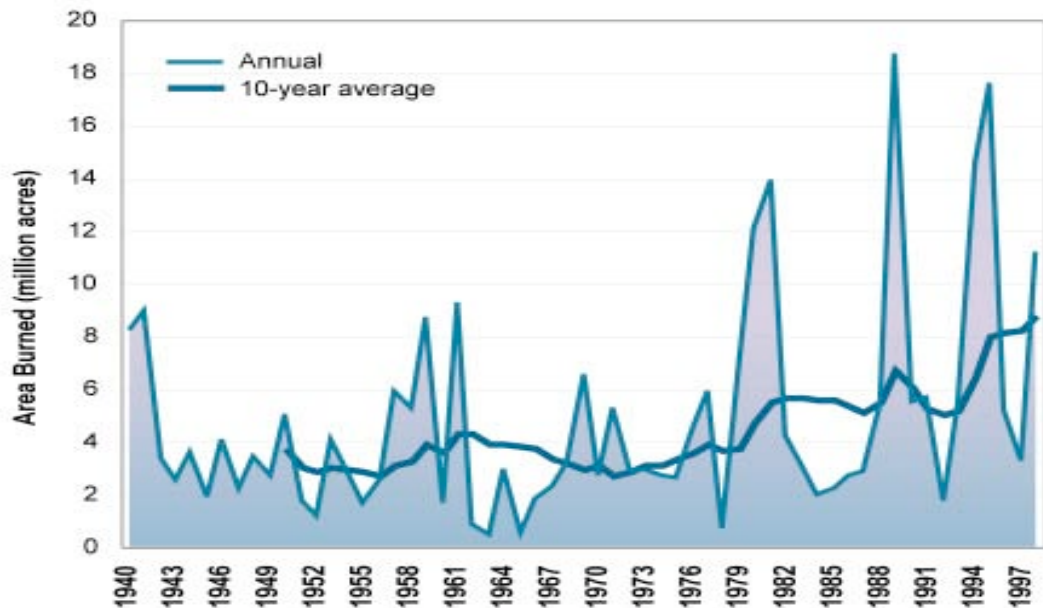
60-year coastal erosion outlook for South Bethany, Delaware -- 3 rows of homes to be lost

Source: Heinz Foundation (for FEMA)



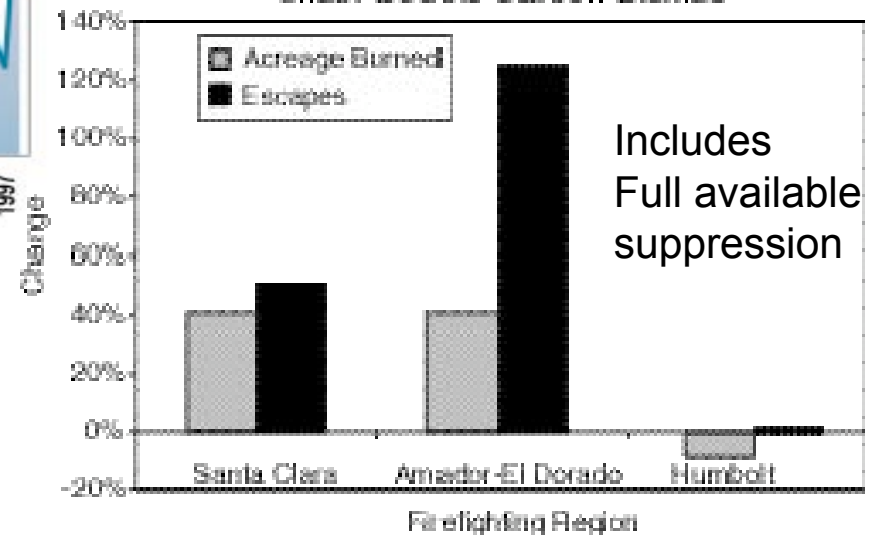
Wildfire

Fingerprint:
Average area of North American boreal forest burned has doubled since 1970



*Development in
wildland/urban
interface
compounds the
problem*

California wildfires increase up
to 4x under climate change
under Double Carbon Dioxide



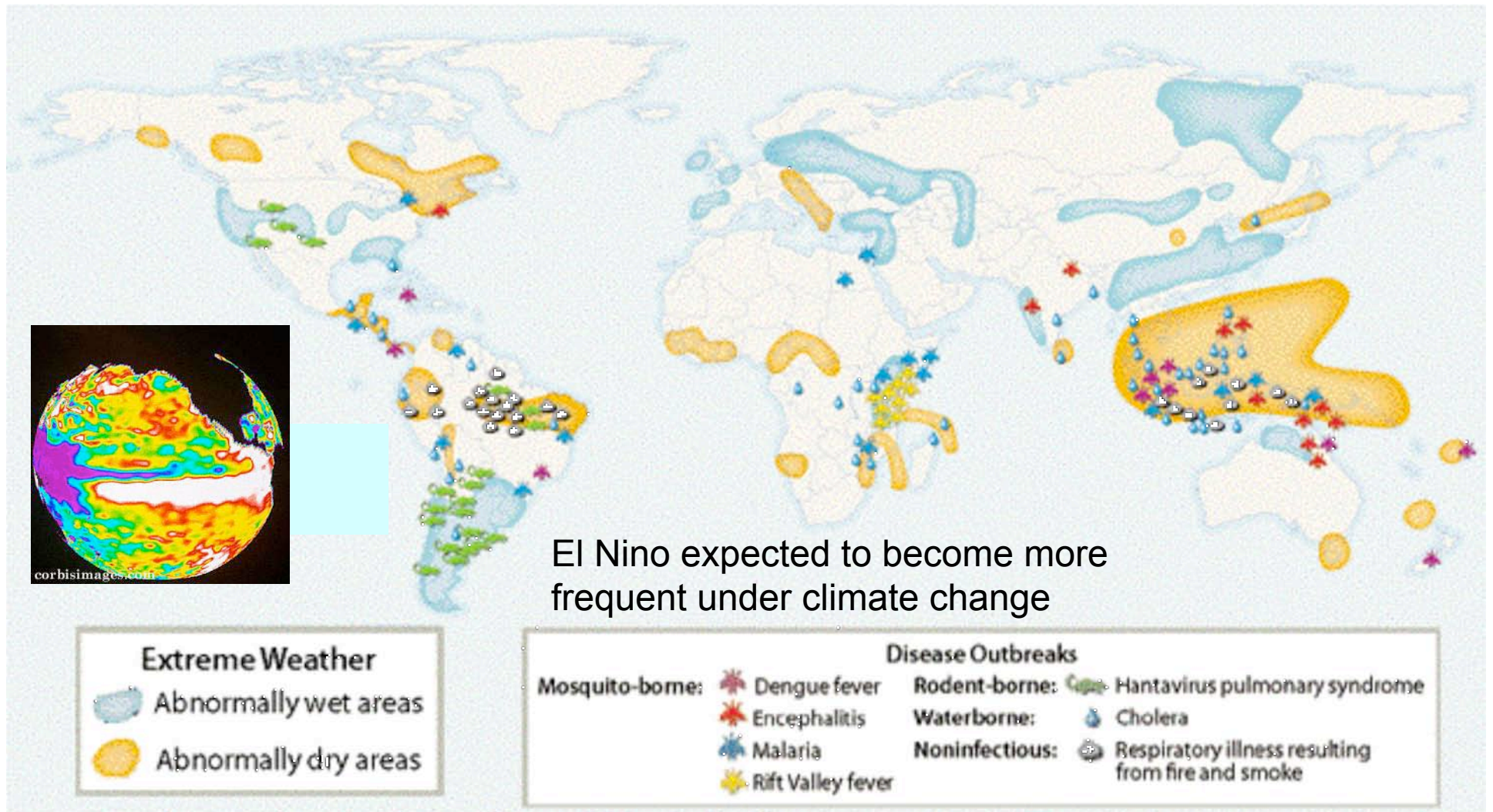
Source: Tom et al. (1998)

Human Health

- Heat catastrophes (mortality and morbidity)
- Respiratory Illness
 - Pollen - e.g. 60% more ragweed pollen at 2x CO₂
 - Mold - product of increased CO₂, temps, and moisture
 - Particulate - fossil fuel combustion; wildfire
 - Temperature-dependent air pollution
- Infectious disease
 - Resurgent and redistributing: dengue fever, Encephalitis, Malaria, Rift Valley Fever, West Nile Virus, Hantavirus, Cholera, Lyme Disease
 - Newly Emerging: Nipah Virus - highly contagious; lethal in > 40% of cases

WHO estimates 150,000 human mortalities each year due to *current* climate change

Correlation of Disease Outbreaks with the 1997-1998 El Nino



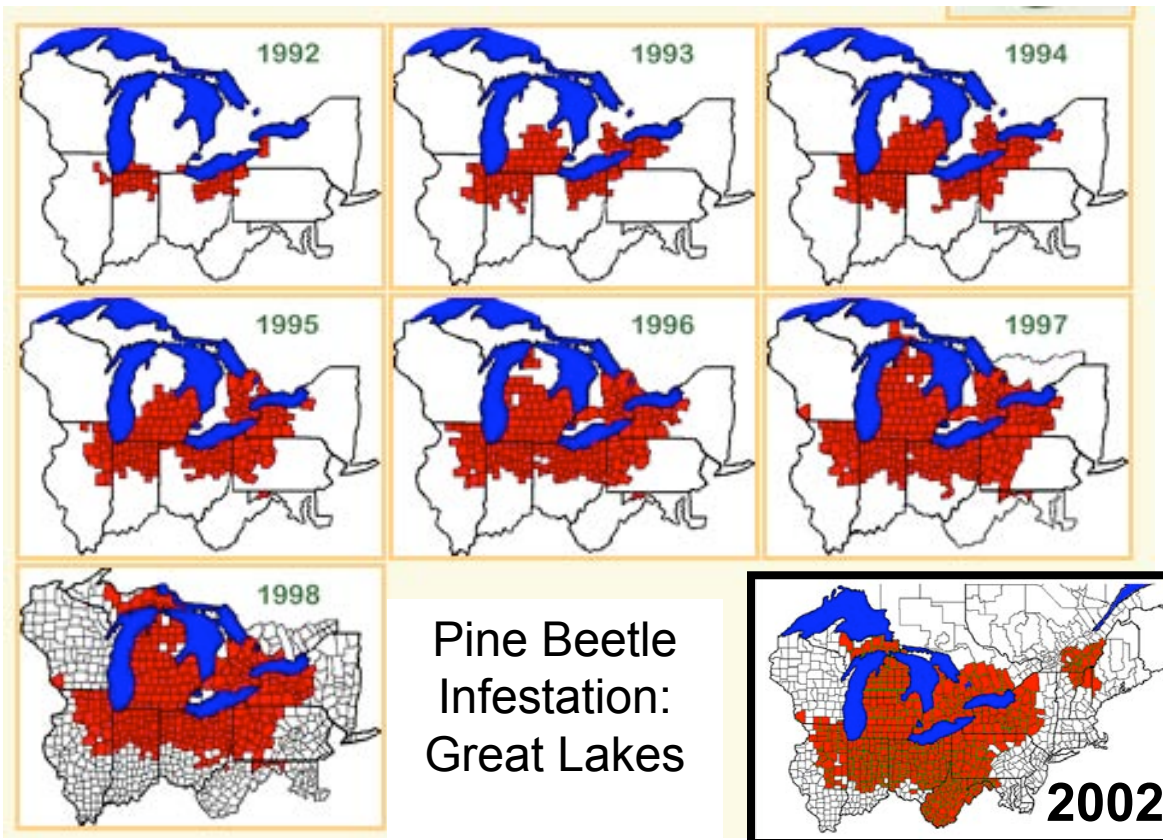
Source: Harvard Medical School, Center for Health and the Global Environment (*Science*)

Health: Other Systems

- Other Systems
 - Insect super-infestations
 - Crop damages and diseases
 - Coral bleaching - implications for coastal protection; tourism; fresh water salinization

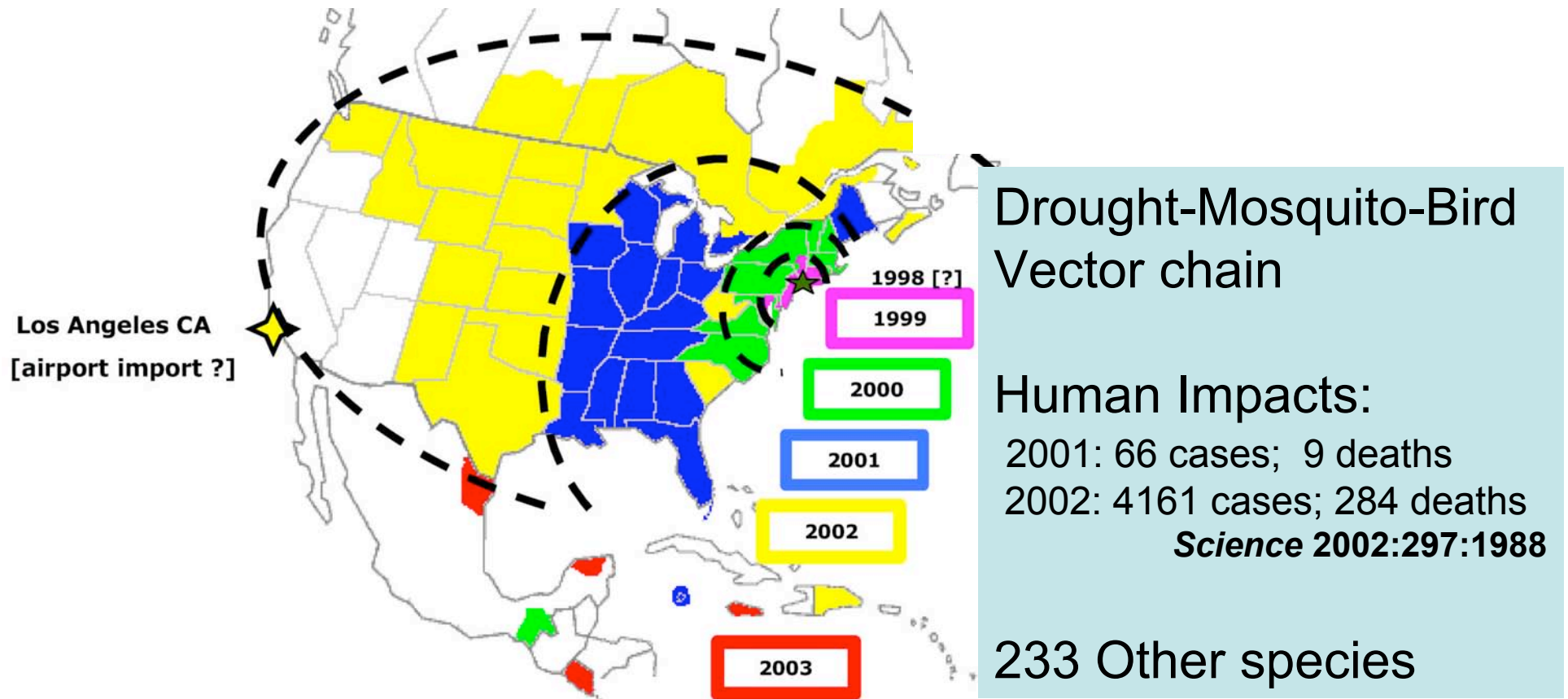


Temperature-driven pine beetle “super infestations”



Residential property and intermixed beetle-kill

Spread of West Nile Virus in North America: 1999-2002



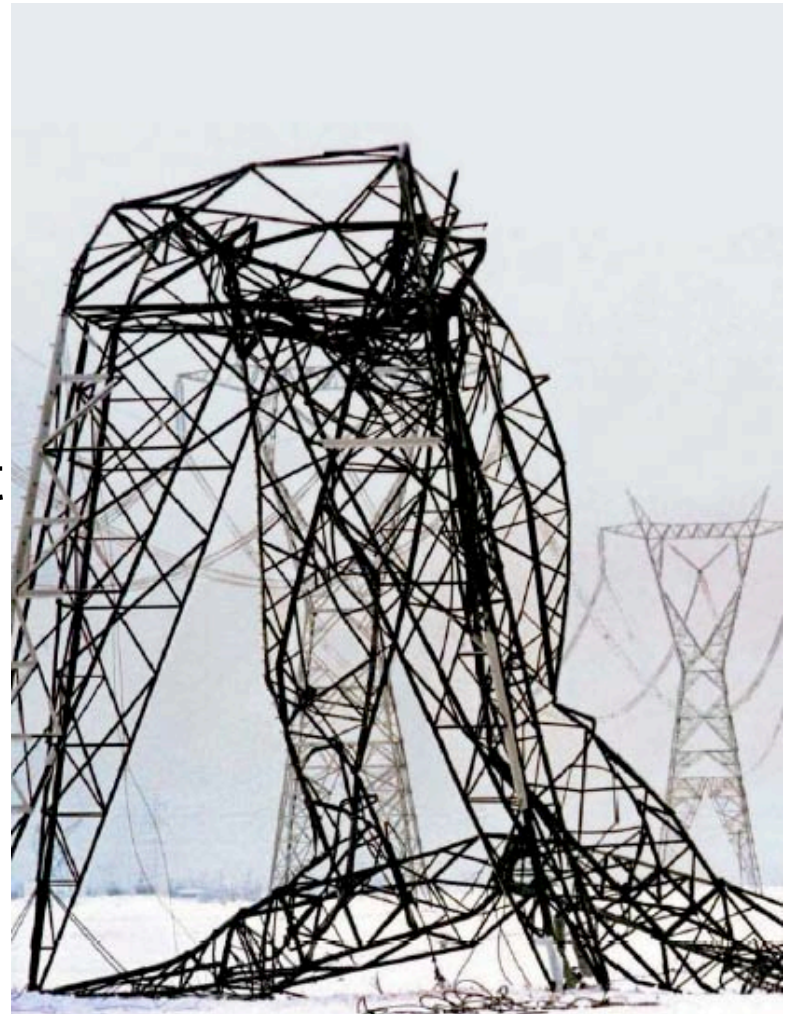
Sources: U.S. Army Environmental Programs Directorate,
from Centers for Disease Control, Health Canada, USGS,
and ProMED-mail as of 14 May 2003)

Sectoral Impacts: Energy

- Vulnerabilities
 - Storm - power transmission
 - Lightning - outages
 - Drought - hydro
 - Temperature - peak demand
 - Subsidence & permafrost melt
 - pipelines, generators
 - Sea level rise - refineries

Current insured losses from outages
unknown: most are below PCS threshold
for being “worth” counting.

US total ~\$80B/year.



Munich Re

Why Worry?

- The future that will *not* mirror the past
- Losses becoming less predictable
- Increased loss frequency
- A shift in location of loss
- More co-incidence and correlation of loss
- Trends not necessarily gradual or linear
- New types of losses (“surprise”)
- Financial and physical CAT models based on past outcomes will have decreasing accuracy

"Everybody talks about the weather, but nobody does anything about it." -- *Charles Dudley Warner (Hartford Courant (1897)*

More Information

<http://eetd.lbl.gov/insurance>

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Source Material

- Primary Sources: *Science* magazine, *Nature* magazine, *Munich Re*, *Swiss Re*
- United Nations / World Meteorological Organization -- Intergovernmental Panel on Climate Change
- John P. Holdren. Presentation to 2003 UN Investors Summit entitled “Risks from Global Climate Change: What Do We Know? What Should We Do?”
- Prof. Don Wuebbles. Presentation to 2005 AAAS Annual Meeting entitled “The Potential Implications of Human Effects on Climate”
- Paul Epstein, M.D., M.P.H., Harvard Medical School, Center for Health and the Global Environment, presentation entitled “Climate Instability and Public Health” 2003.